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Before the
Federal Communications Commission
Washington, D.C. 20554

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Federal Communications Commission
Office of Secretary

In the Matter of	)	
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Amendment of Parts 2 and 15 of the	)	ET Docket No. 96-8
Commission's Rules Regarding Spread	)	RM-8435, RM-8608, RM-8609
Spectrum Transmitters	)	

Amtech Corporation
Petition for Clarification

Amtech Corporation respectfully asks the Commission to clarify that the definition of *frequency hopping systems* includes systems in which the RF carrier is modulated through conventional modulation applied by means of modulated backscatter. Amtech also urges the Commission to clarify that the definition of *direct sequence systems* permits the information data stream to be applied by means of modulated backscatter to a carrier that has been modulated by a high speed spreading code. The clarification sought is consistent with the wording of the definitions of frequency hopping systems and direct sequence systems set forth in Section 2.1(c) of the Commission's Rules as adopted in the *Report and Order*[1] in this proceeding. Such a clarification will further the Commission's goal of facilitating the application of innovative beneficial technology that utilizes the interference mitigation techniques of spread spectrum system.

[1] Report and Order, ET Docket No. 96-8, FCC 97-114, 12 FCC Rcd _____ (rel. April 10, 1997).

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Background

Amtech is the leading developer and manufacturer of modulated backscatter radio frequency identification systems. Founded in 1984 by a group of scientists who left the Los Alamos National Laboratory, Amtech's modulated backscatter technology stands as one of the prime examples of the transfer of government research to the commercial sector. In essence, modulated backscatter works by imposing information on an RF carrier that illuminates a tag. The tag is "passive" in the sense that it does not contain an active intentional radiator. Instead, the circuits in the tag impose modulation on the RF carrier so that a reader can decode the modulated signal scattered back from the tag. The modulated signal is used to provide information about the vehicle to which the tag is attached. In its simplest form, the tag supplies a unique identification number that is associated with the vehicle or vehicle cargo. Today, Amtech systems operate in twelve countries. In the United States, Amtech tags are used on 1.5 million railroad cars and about 600,000 cars and trucks. Worldwide, Amtech has sold over seven million tags.

The primary markets for Amtech technology thus far have been in rail and electronic toll and traffic management applications. Traditionally, these applications have been served by licensed stations operating in the 902 - 928 MHz band on fixed frequencies. These systems have been licensed at powers of up to 32 watts (with 30 watts ERP being the current maximum). In such cases, the Amtech tag readers have been positioned at toll plazas, on gantries placed over highways, on cargo moving systems, and along railroad tracks.

The same basic technology used in the rail and toll markets can also serve important needs in providing secure electronic access control for garages, freight depots, and other applications requiring identification as a condition of access. Many of these applications can

be met with lower power (less than 3 watts eirp) than that needed for the relatively high speed toll and rail applications. Indeed, the power limitations of Section 15.247 are quite adequate for a host of applications involving access control at garage entrances as a means for increasing security and as a tool for improving the efficiency of logistics handling in warehouses and freight yards served by trucks and railroads.

The Need for Clarification

The difficulty in applying spread spectrum technology under Section 15.247 lies not with the definition of frequency hopping systems and direct sequence systems. Instead, it appears that there is a reluctance to recognize systems in which the modulation is applied by means of "backscatter." In such systems, the modulator is displaced from the transmitting system by the distance from the transmitting antenna to the tag that imposes modulation (*i.e.* modifies the signal to impress information upon the carrier). Within the last year, the Commission has authorized on a Part 15 spread spectrum basis modulated backscatter systems in which the "reader"[2] also transmits a modulated signal from the reader to the tag so as to "write" to the tag and then transmits an unmodulated signal upon which the tag imposes modulation. Technology of this kind has been approved under the spread spectrum rules consistent with an unpublished staff interpretation dating from 1993.[3] The clarification sought

[2] The "reader" is typically that part of the system that is comprised of a means for generating an RF carrier, circuitry to decode the modulated signal received from the tag, and an antenna that is used for radiating the carrier to the tag and receiving the signal from the tag after it has had information impressed upon it. In some systems, a separate antenna may be used to illuminate the tag with the carrier and another antenna used to receive the modulated signal that is scattered back from the tag.

[3] See Letter of March 17, 1993, to Lawrence J. Movshin, File 31020, 1300B1.

in this petition urges the Commission also to permit systems in which the intelligence to be transmitted is imposed on the carrier solely through modulated backscatter.

In the *Report and Order* the Commission defined *frequency hopping systems* as

> [a] spread spectrum system in which the carrier is modulated with the coded information in a conventional manner causing a conventional spreading of the RF energy about the frequency carrier. The frequency of the carrier is not fixed but changes at fixed intervals under the direction of a coded sequence. The wide RF bandwidth needed by such a system is not required by spreading of the RF energy about the carrier but rather to accommodate the range of frequencies to which the carrier frequency can hop. The test of a frequency hopping system is that the near term distribution of hops appears random, the long term distribution appears evenly distributed over the hop set, and sequential hops are randomly distributed in both direction and magnitude of change in the hop set.[4]

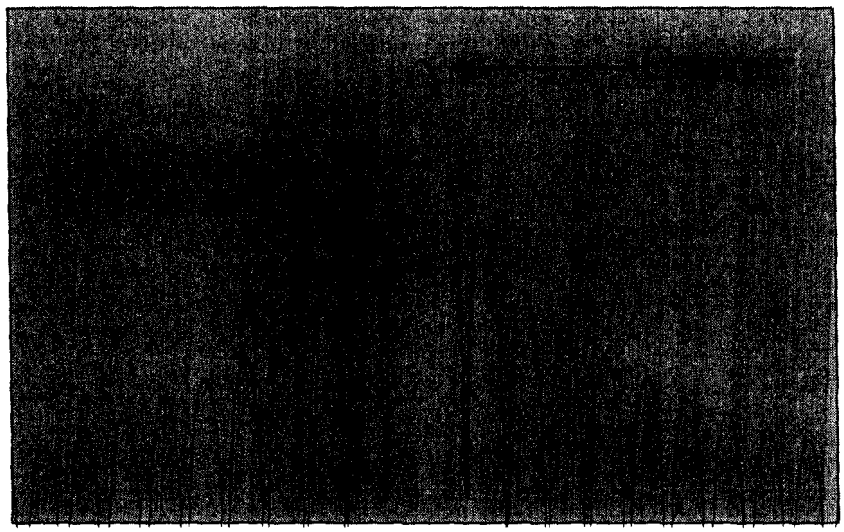
Apart from a concern that modulated backscatter is not "conventional," there appears to be no basis for requiring that the reader also transmit a signal that is modulated within by the circuitry of the reader as opposed to being modulated by the tag circuitry, which is at most a few meters removed from the reader. Thus, in the presence of the tag, the signal is modulated. As for the conventional nature of the modulation, modulated backscatter systems can impose modulation on a carrier using such conventional modulation schemes as amplitude modulation (AM), phase modulation (PM), and frequency shift keying (FSK).

The major difference between the signal that has been modulated using a backscatter approach and one that has been modulated in frequency hopping spread spectrum systems deployed heretofore is not the aspect of the carrier that is changed in order to convey

[4] Report and Order, ET Docket No. 96-8, FCC 97-114, 12 FCC Rcd ____ (rel. April 10, 1997).

information. Rather, it is the depth of modulation. Figure 1 shows a signal amplitude modulated to about 70%.

Figure 1



In a backscatter system, such as that depicted in Figure 2, the modulated signal typically exhibits a low index of modulation.

Figure 2

The energy surrounding the modulated carrier is much lower in amplitude than the carrier.[5] Consequently, the interference potential for such a system is lower than that of a system with a much higher percentage of modulation in which the energy near the carrier occupies spectrum at a much higher level. Thus, a frequency hopping system in which the modulation is applied at the tag would have to have its carrier fall well within the bandpass of a victim receiver in order for interference to occur. In contrast, a frequency hopping system that applied modulation in the reader circuits would have the potential to put more energy over a wider bandwidth and could desensitize a victim receiver without having its carrier fall well within the bandpass of the receiver.

A direct sequence system would have the spreading code applied in the reader and the modulation for the intelligence to be transmitted applied via modulated backscatter. Heretofore, the definition of direct sequence system could have posed greater difficulty for the use of modulated backscatter because of the way in which the spreading modulation and the information modulation had to be combined.[6] The new definition, however, does not appear to impose an impediment of this nature. Any such direct sequence system, however, would still need to meet power spectral density requirements and exhibit processing gain thereby demonstrating that it has the interference mitigation characteristics of a spread spectrum

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[5] In a typical system, the modulated signal strength as read at the reader is about 40 dB below the carrier.

[6] Section 2.1(c) in the prior rules required that the data stream containing the information to be transmitted be "modulo 2 added to a higher speed code sequence." The Commission recognized in the Notice of Proposed Rule Making ("NPRM") in this proceeding that such a requirement was "outmoded." NPRM, ET Docket No. 96-8, 11 FCC Rcd 3068, 3075 (rel. Feb. 5, 1996).

system. To the extent that a direct sequence system using modulated backscatter could be perfected, the rules should be interpreted to permit the use of such techniques.

In the case of frequency hopping systems and direct sequence systems that use modulated backscatter, a question could arise as to compliance with the definition in cases in which the tag is not present to provide the modulation of the information to be transmitted. For handheld readers designed to be triggered manually, this should present little cause for concern because the operator would not be likely to activate the transmitter unless a tag was thought to be present. In other situations such as access control, the transmitter can be actuated by means of a proximity switch or other technique that would place the transmitter on the air only when a vehicle or object likely to be tagged came within the range of the reader.[7] If no tag is read within 400 milliseconds, such systems can be designed to shut down.[8] Thus, the likelihood of a continuous hopping carrier in the presence of no tag to modulate the signal would be extremely low.

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[7] Modulated backscatter readers are inherently very short range communications systems because of the low level at which the signal is modulated. For a 902 -228 MHz system using a tag that draws power for the modulator from the RF energy radiated by the reader, the range would be on the order of two to three meters. As a practical matter, such a system would need to employ a directional antenna in order to achieve this range. The use of a directional antenna would further minimize the probability of the system to cause interference.

[8] Of course, a frequency hopping system of this kind would also need to comply with the requirements that it employ a pseudorandom hopping sequence so that the next read attempt would be on a different frequency.

Conclusion

Modulated backscatter technology as implemented by many manufacturers today serves a host of socially beneficial purposes. Toll roads operate more efficiently thanks to this technology and thereby save drivers time and money while providing an environmental benefit. The same technology helps to move the nation's rail, truck, and air freight more efficiently. It can also provide a highly secure means for granting vehicles access to restricted areas. Some applications of modulated backscatter technology can be implemented using spread spectrum technology within the confines of the definitions set forth in Section 2.1(c) and the requirements of Section 15.247 of the Rules. Amtech urges the Commission to clarify in this proceeding that the revised spread spectrum regulations afford a framework within which this beneficial technology can be authorized on an unlicensed basis.

Respectfully,

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June 12, 1997